Atrazine Ecological Effects Assessment for OPP Level of Concern and OW Water Quality Criterion for Aquatic Life

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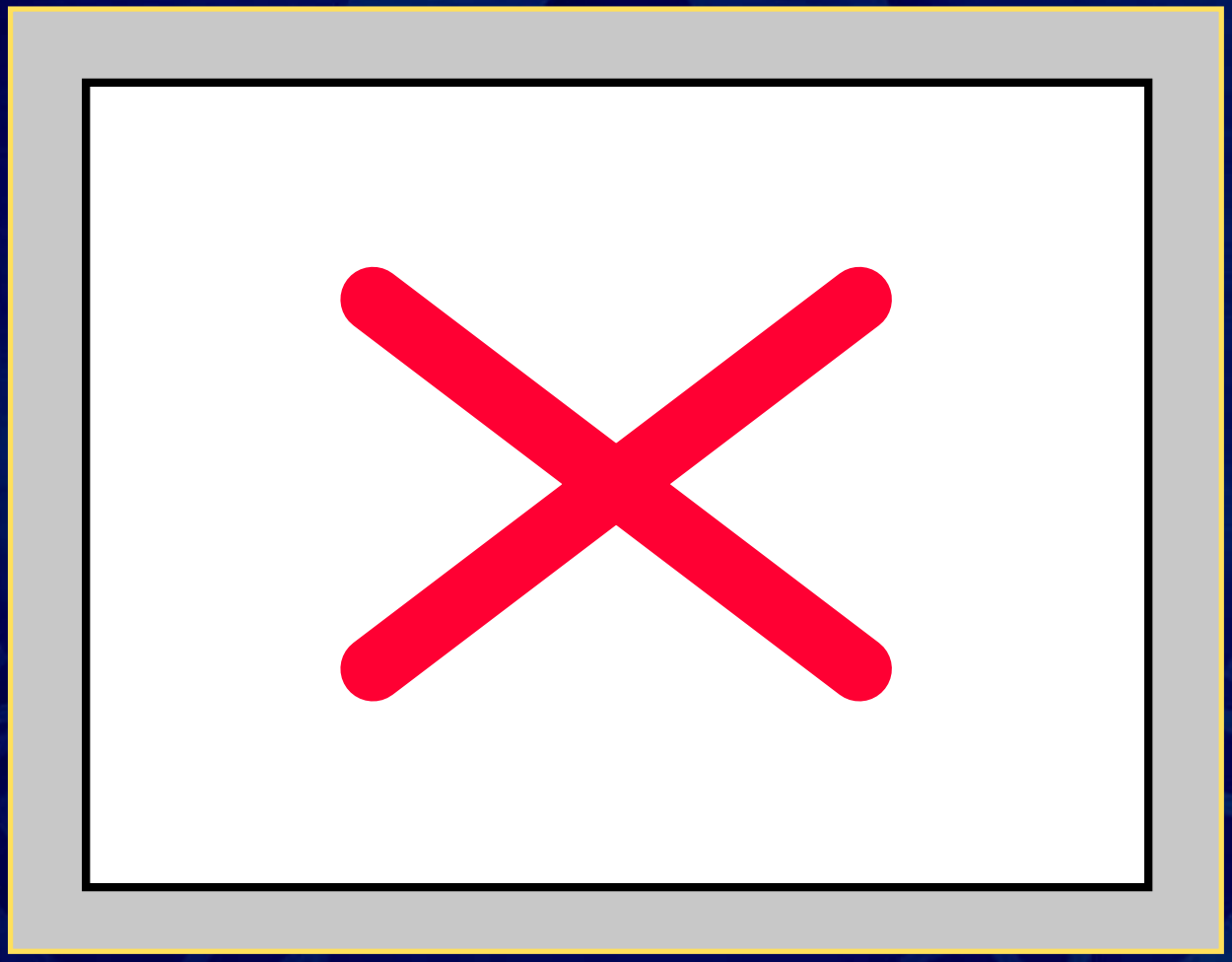
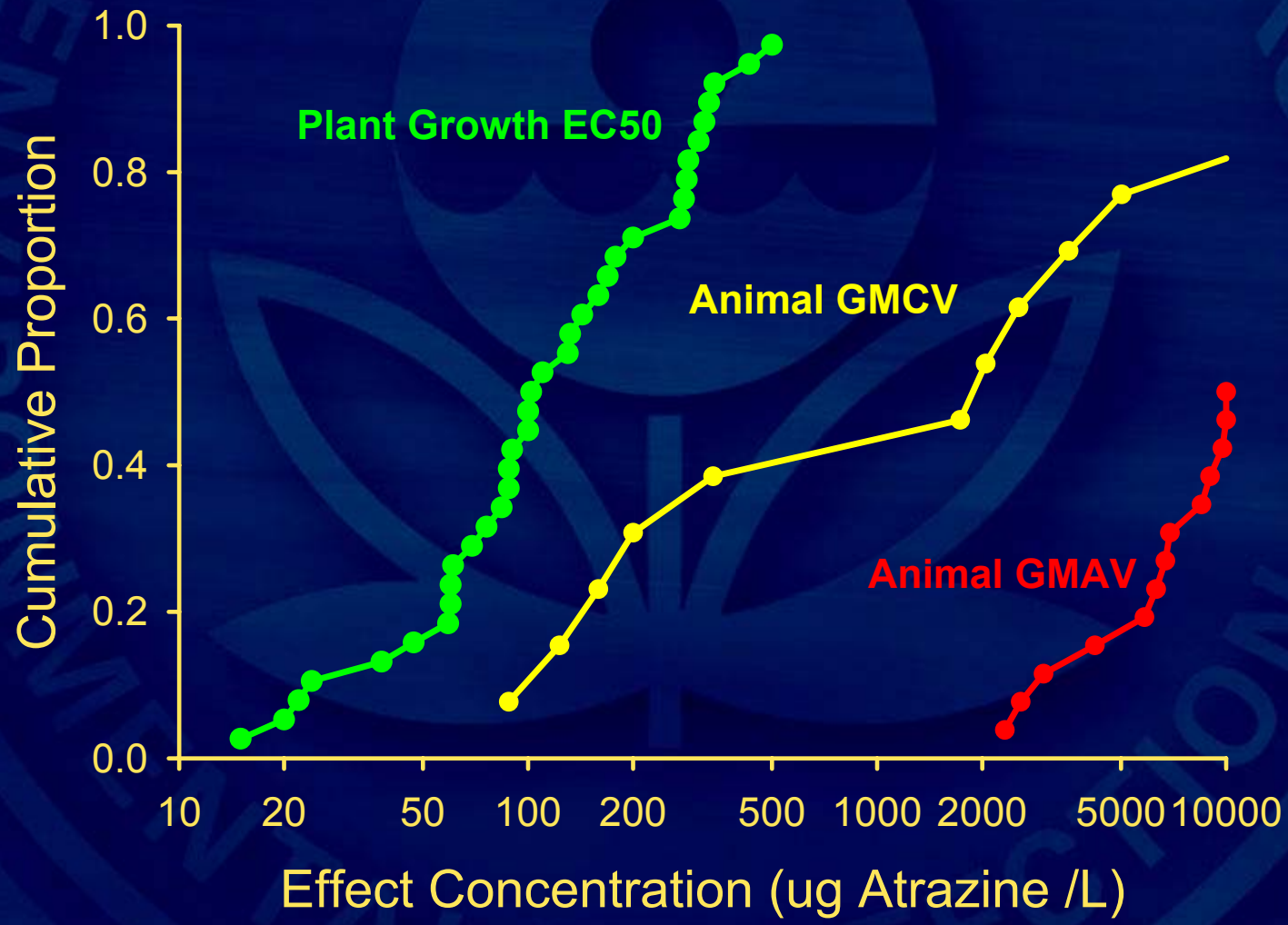
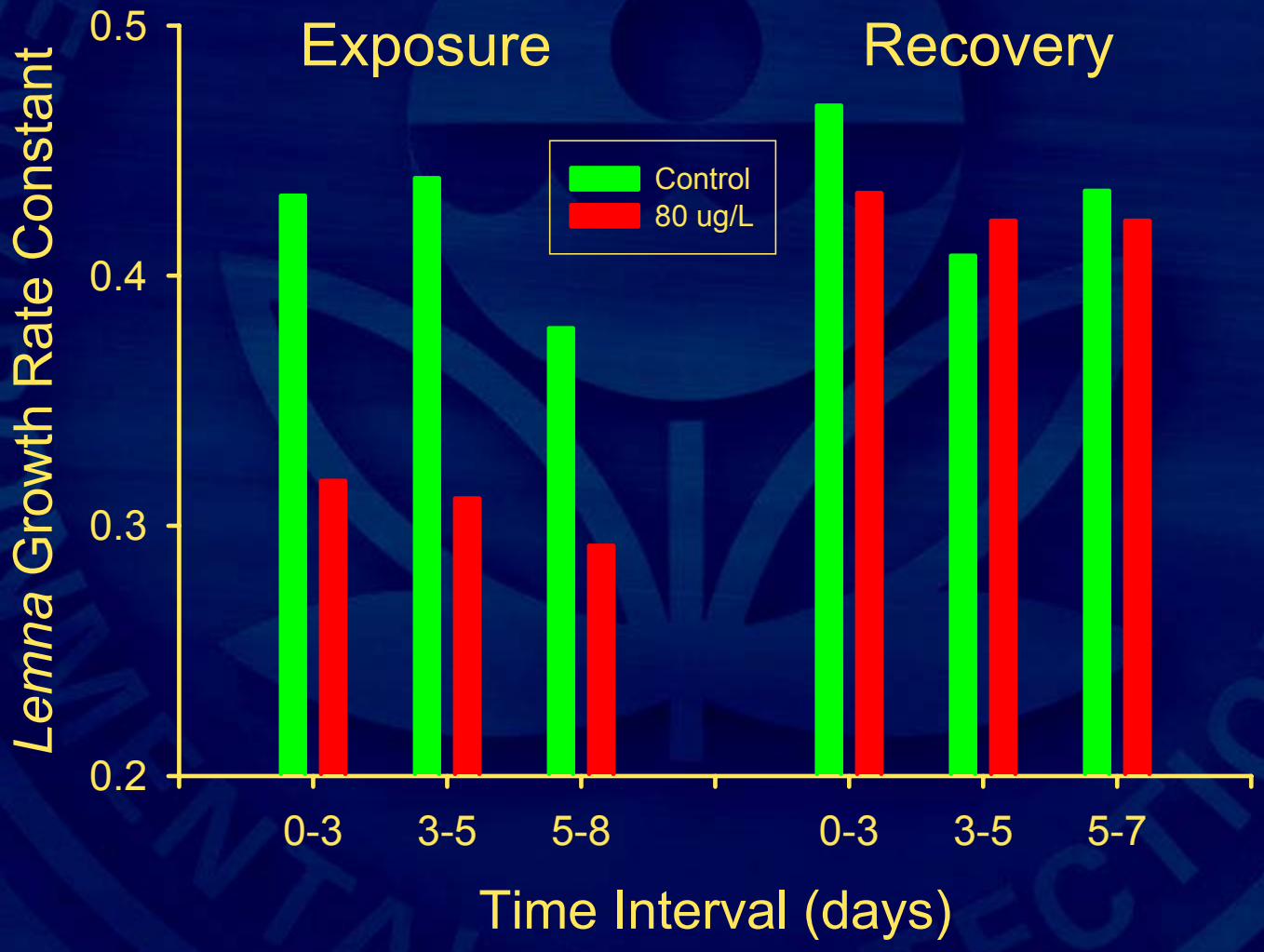
Background – Regulatory Context



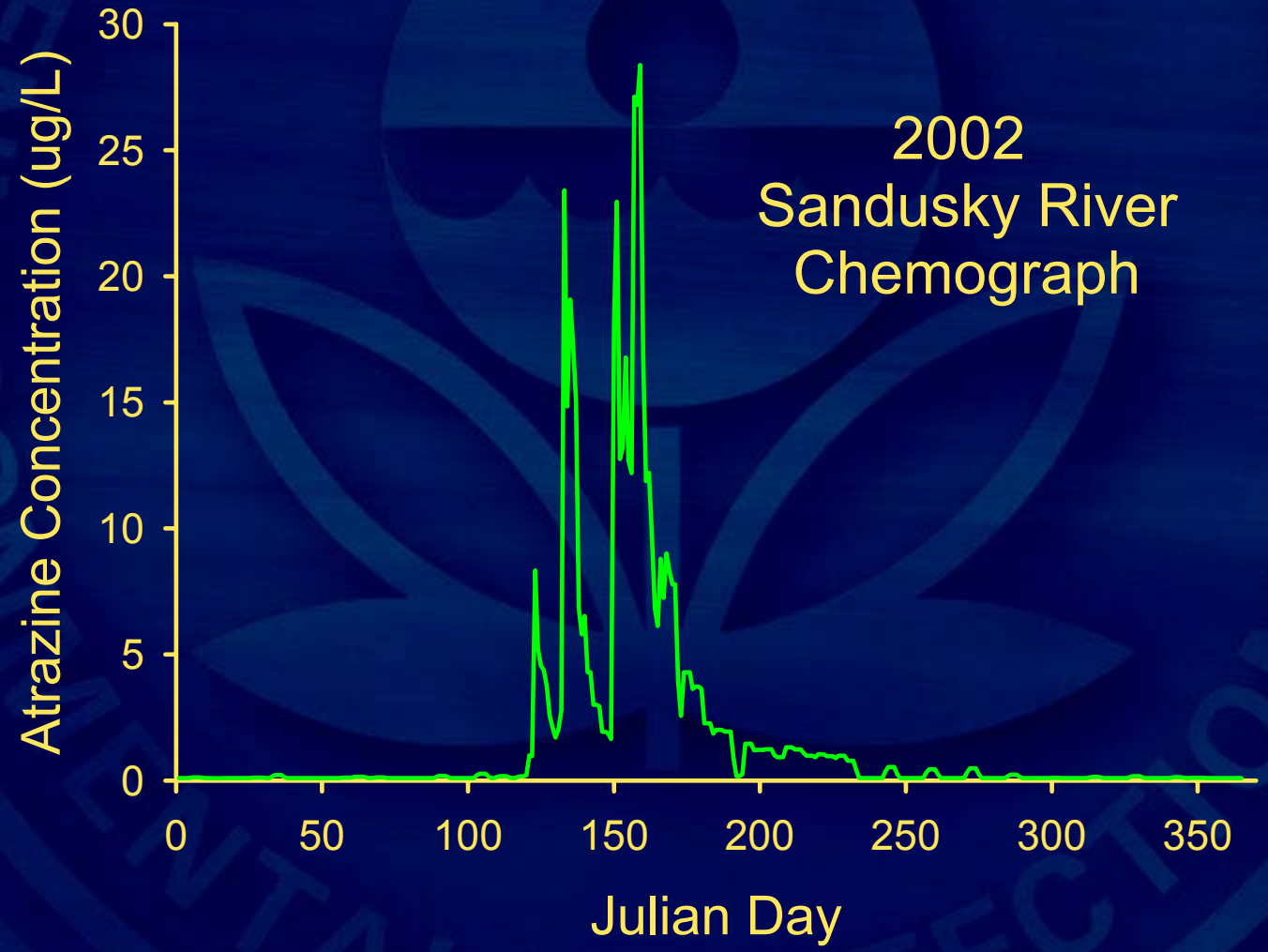
Background – Single Species Toxicity



Background – Kinetics of Plant Toxicity



Background – Exposure Variability



Major Issues for Effects Assessment

(1) What levels of effect across multiple plant species are of significance to aquatic communities?

(2) How should effects be quantified for highly time variable exposures?

Microcosm and Mesocosm Studies

- 77 reported results from 25 studies, including ponds/lakes, artificial streams, and laboratory microcosms.
- Effects scored according to Brock et al. (2000):

  1 = No effect

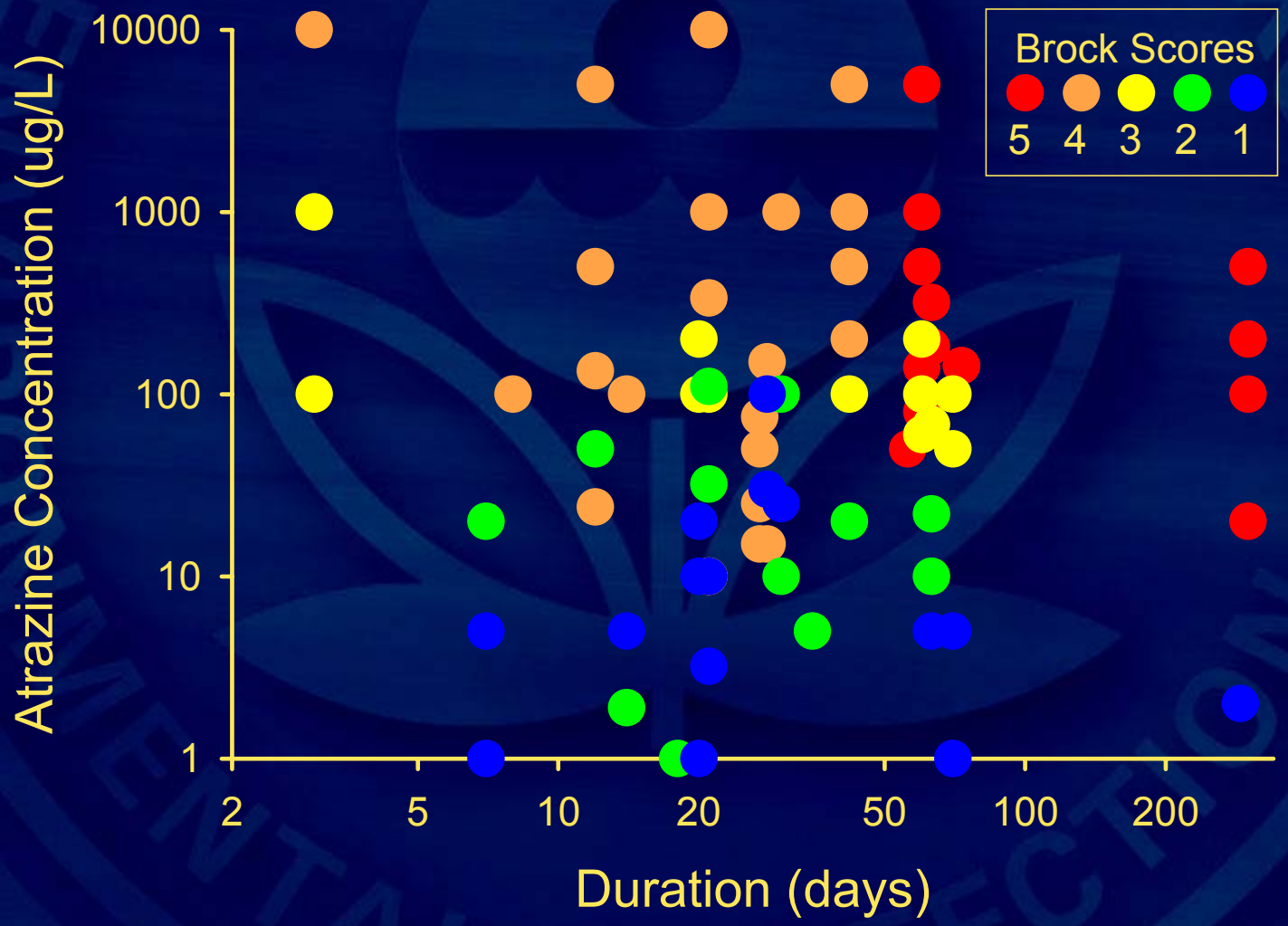
  2 = Slight effect

  3 = Significant effect with return to control levels during an observation period of < 56 days

  4 = Significant effect w/o return to control levels during an observation period of < 56 days

  5 = Significant effect with return to control levels during an observation period of >= 56 days

Microcosm and Mesocosm Studies



Aquatic Community Simulation Model

- Bioenergetics-based food web model "CASM" (Comprehensive Aquatic Simulation Model, DeAngelis et al. 1989, Bartell et al. 1999, 2000)
- Model components (2^{nd}/3^{rd} order stream):

  10 species of phytoplankton

  10 species of periphyton

  6 species of macrophytes

  2 species of zooplankton

  5 species of benthic invertebrates

  8 species of fish

  bacteria and cyanobacteria

Aquatic Community Simulation Model

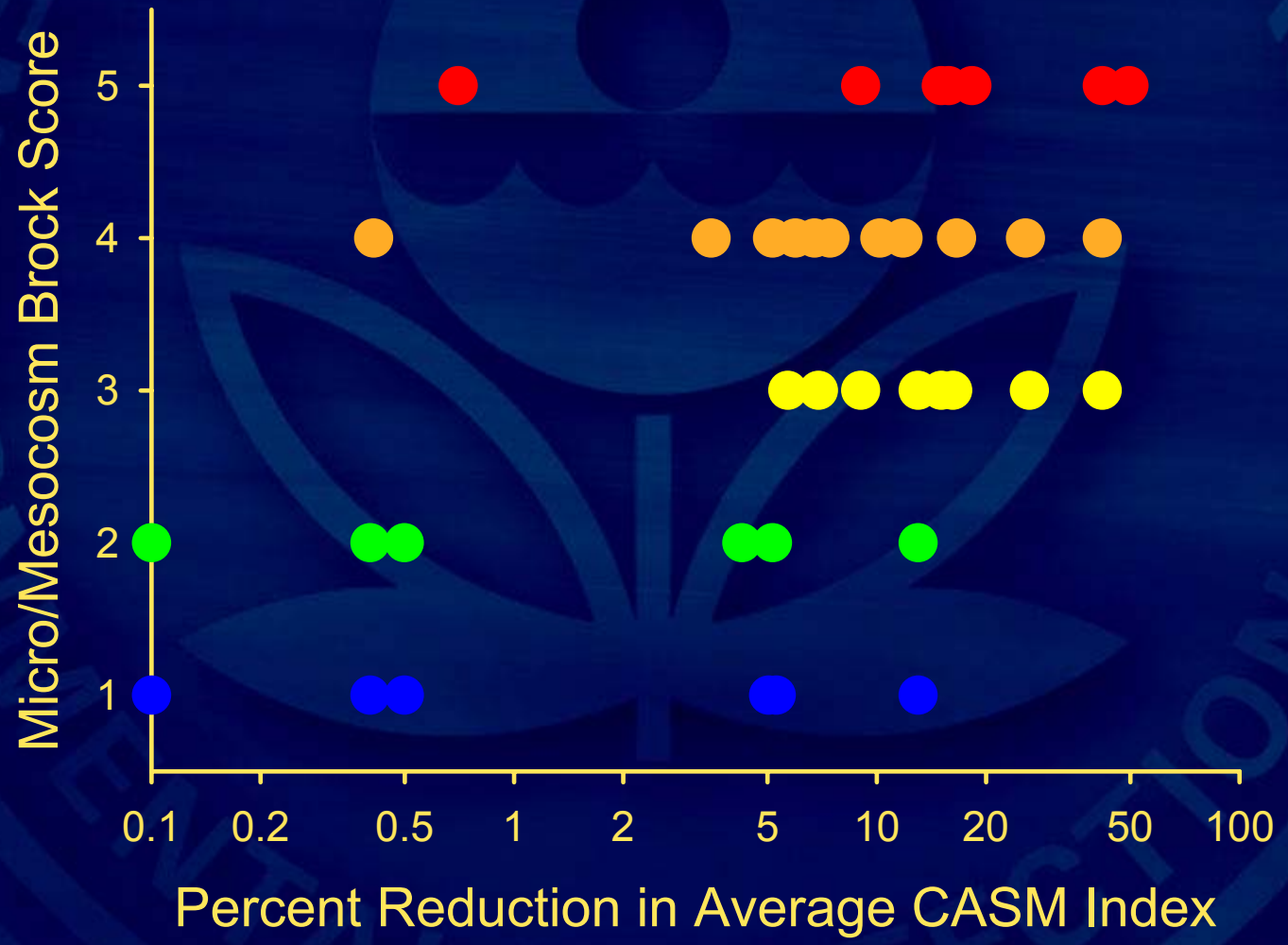
- **Model Parameterization: Available single-species toxicity data used to develop concentration/response relationships for parameters in each species' bioenergetics equation.**
- **Model Output Variable: Integrated measure of effects on entire primary producer community (Steinhaus Similarity Index), averaged over 260-day simulation period.**
- **Model Simulations: 100 Monte Carlo simulations for each exposure scenario to determine effects of parameter variability and uncertainty.**

Aquatic Community Simulation Model

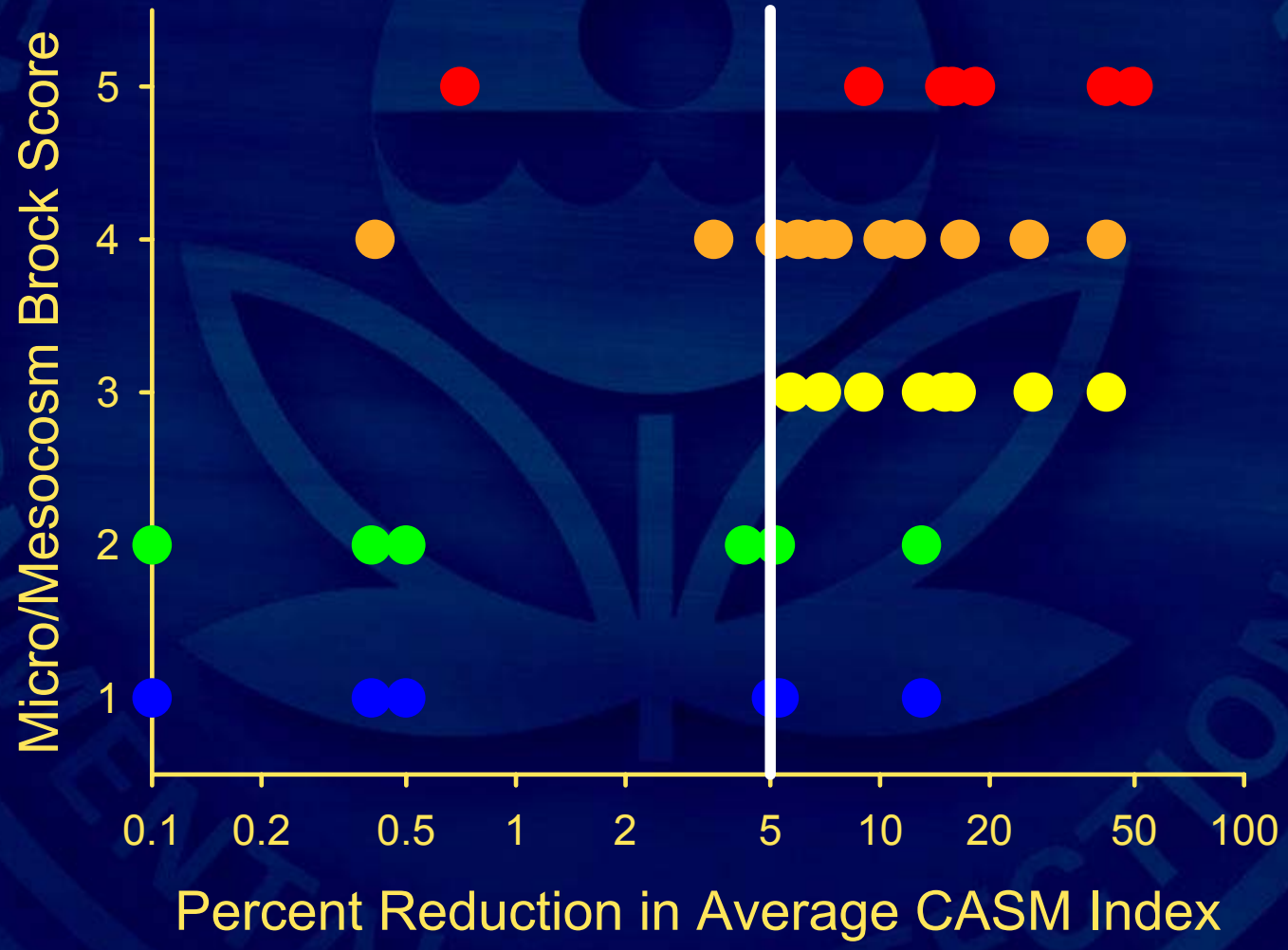
Predicted Average % Reduction in Similarity Index

Atrazine ug/L	Pulse Duration (days)							
	1	3	5	10	20	60	130	260
20	0.0	0.0	0.1	0.4	0.4	0.5	0.5	0.7
30	0.4	1.2	2.0	3.5	5.2	7.6	8.4	8.7
40	0.8	1.8	2.6	4.1	5.8	8.3	9.3	9.7
50	0.8	1.8	2.6	4.2	6.0	8.9	10.1	10.7
70	2.2	4.8	6.4	9.1	11.6	14.9	16.9	17.5
90	2.6	5.6	7.4	10.2	12.8	15.8	17.5	18.0
130	2.6	5.6	7.4	10.2	12.7	15.4	16.3	16.4
170	2.9	6.8	9.8	16.3	25.5	40.6	46.3	48.4
220	2.9	6.8	9.8	16.4	25.5	40.6	46.3	48.4

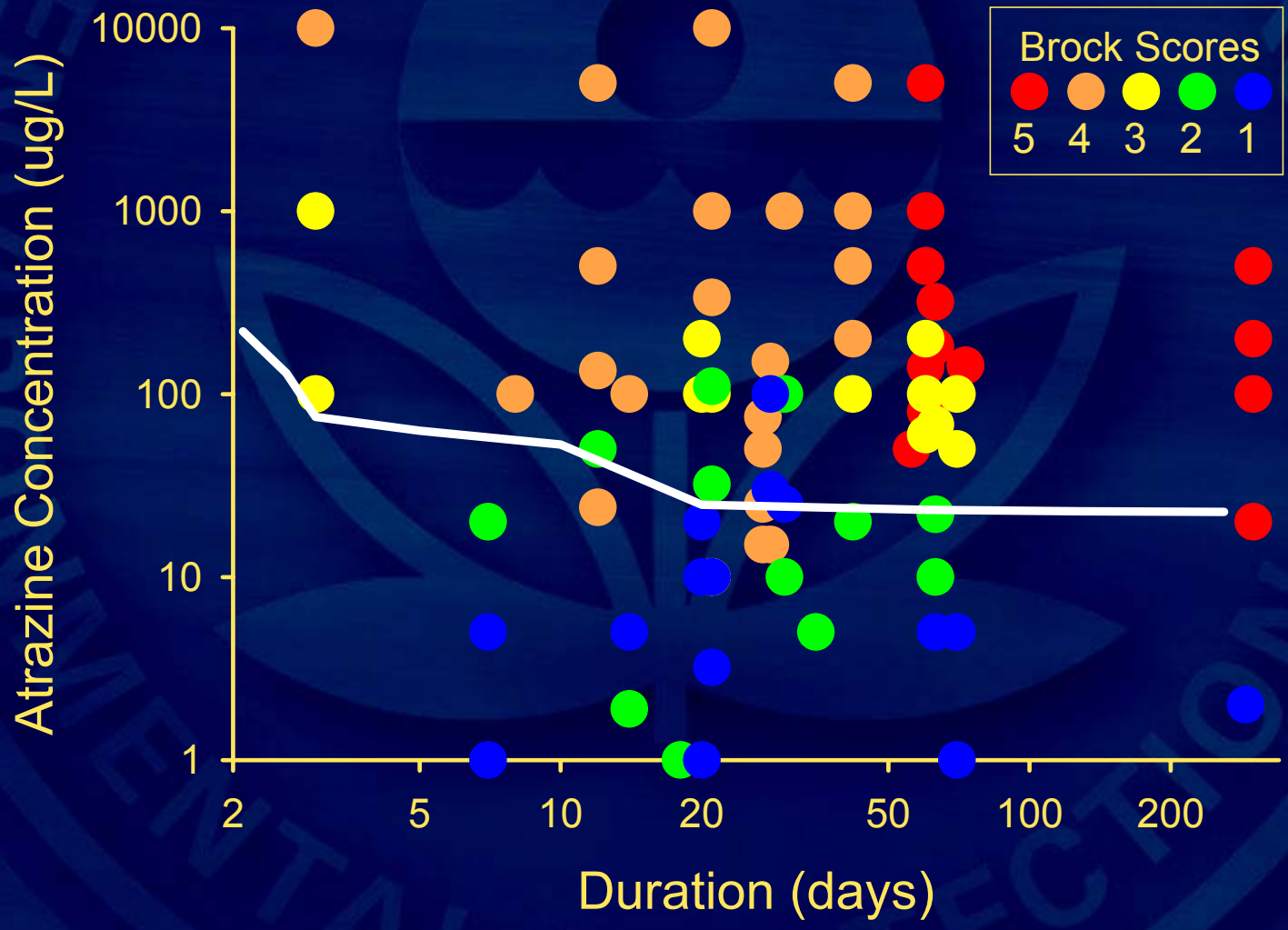
Micro/Mesocosm *versus* CASM Results



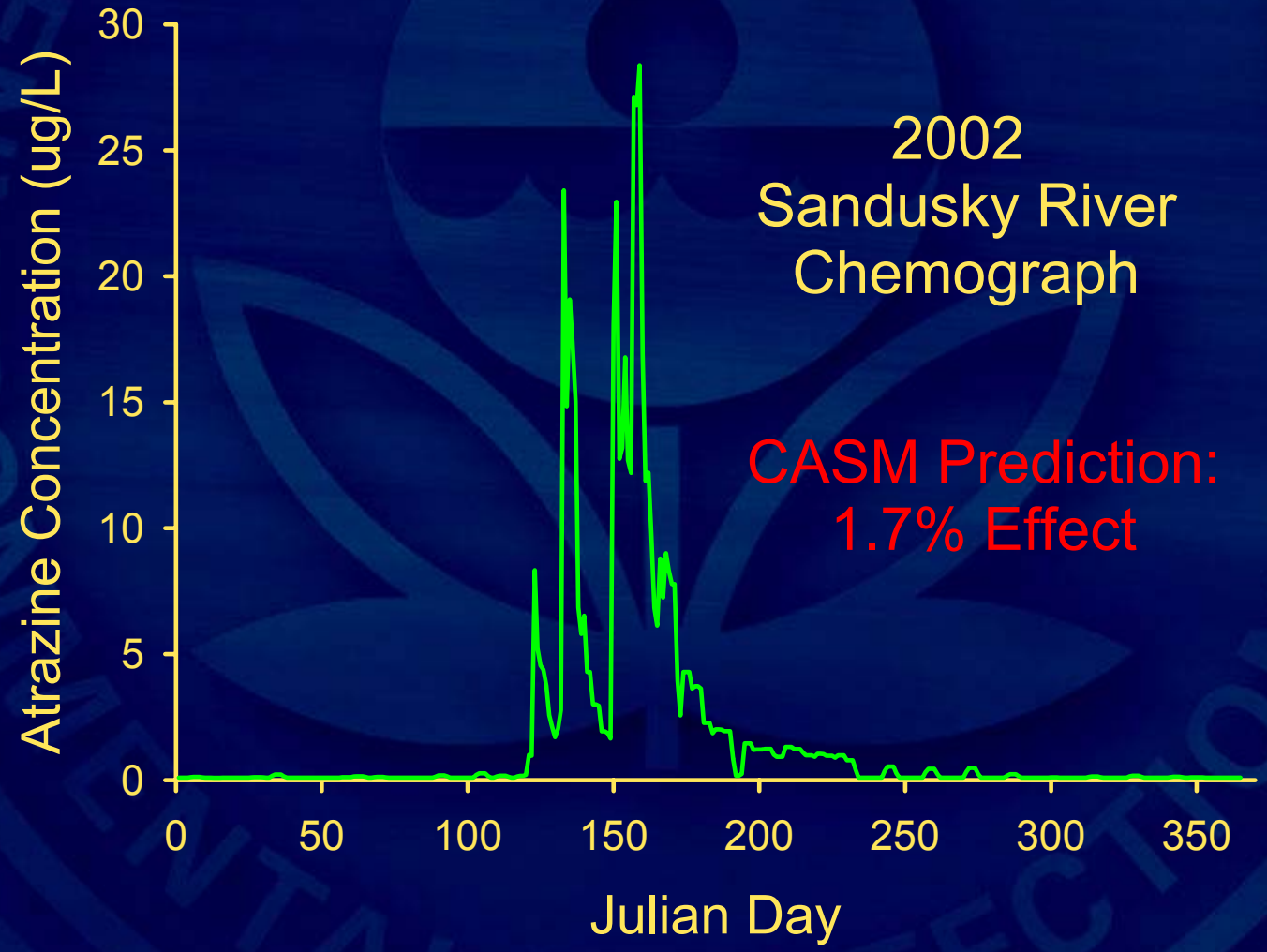
Micro/Mesocosm *versus* CASM Results



Micro/Mesocosm *versus* CASM Results



Application of CASM to Monitoring Data



LOCs Based on Average Concentrations

- CASM was applied to a large number and variety of exposure time series to determine average atrazine concentrations which effectively discriminate >5% and <5% CASM-predicted effect.
- For 1% false negatives (2-5% false positives):

  14-day average = 37.7 ug/L

  30-day average = 26.8 ug/L

  60-day average = 17.5 ug/L

  90-day average = 11.8 ug/L

Important Points About Model Use!!!!

- It is NOT assumed that CASM or similar models provide an accurate representation of absolute responses of aquatic communities, and such an ability is not needed in this application!

- Rather, the significance of the model output variables is determined by referencing them to the micro/mesocosm toxicity tests results.

- Therefore, the key assumption is that the models adequately represent the time-dependence of important aquatic community processes needed to predict RELATIVE changes among different exposure time-series.

Summary and Current Efforts

- This approach to developing water quality criteria is distinguished by (a) the use of micro/mesocosm data to establish exposures of concern and (b) the use of aquatic community models to extrapolate among different exposure scenarios.

- Current collaborative efforts by OPP, OW, and ORD are further developing and evaluating critical aspects of this methodology (especially regarding model parameterization and output variables) and conducting comparisons among different models.